

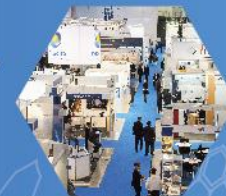
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450mm synergies for smaller wafer diameters: contamination control

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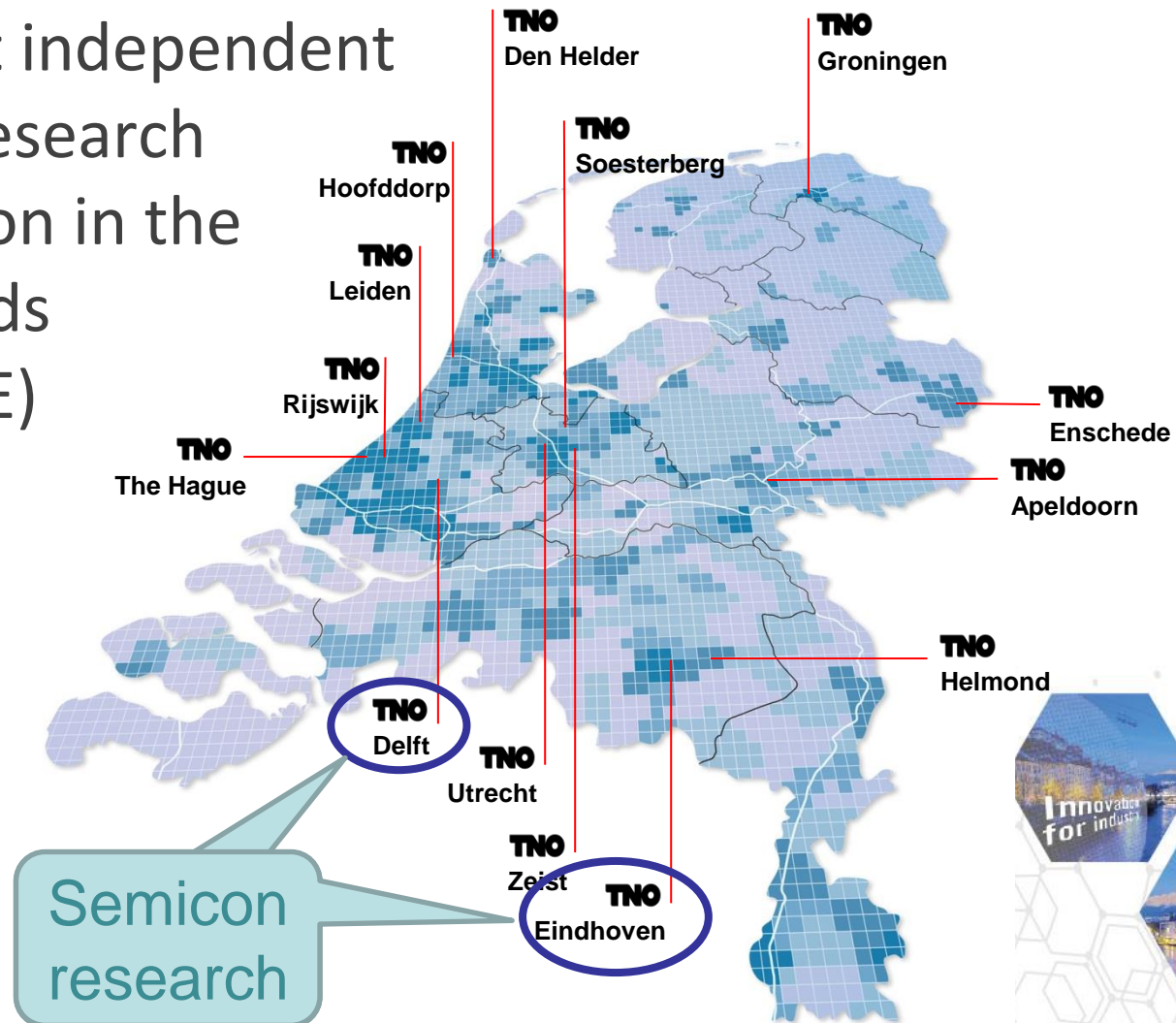
Outline

- Introduction TNO
- TNO view on 450mm synergies for smaller wafer diameters
- Applying 450mm contamination control technology to 300mm and Xnm equipment and processes
- Current and planned research activities at TNO
- Strategies and opportunities beyond the 450mm transition
- Conclusion



TNO is ...

the largest independent
contract research
organisation in the
Netherlands
(>3200 FTE)



Track record

TNO has:

- Performed over 15 years optics lifetime research for EUV and DUV Lithography
- Realised reticle handler, electrostatic clamps and level sensor for EUV Alpha Demo Tool
- Developed modules for removal of molecular and particle contamination
- EUV Lab including EUV beam line, platform for ultraclean reticle handling, outgassing measurement systems, particle scanners, ...



TNO view on 450mm synergies

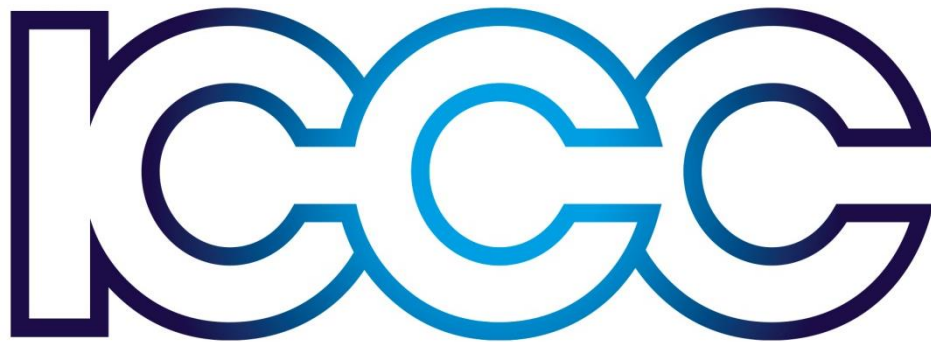
- A successful transfer of 450mm innovations to other areas is essential to ensure the continuity and profitability of the semiconductor industry
- Many opportunities for synergy, including:
 - Better uniformity in front end processing
 - Wafer stage positioning and overlay
 - Fast computing (lithography and metrology)
 - Contamination control innovations



450 mm synergies in contamination control: what can we re-use?

- Backside 450mm wafer cleaning
- Hydrocarbon containment in 450mm metrology tools
- High Throughput Scanning Probe Microscopy
- Ultraclean handling





INTERNATIONAL CENTRE FOR CONTAMINATION CONTROL

Current and planned research activities
at TNO on molecular and particle
contamination control



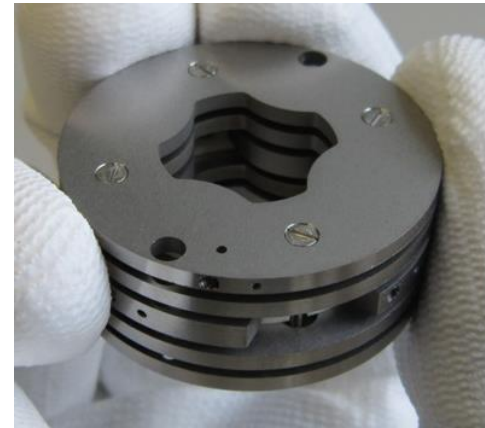
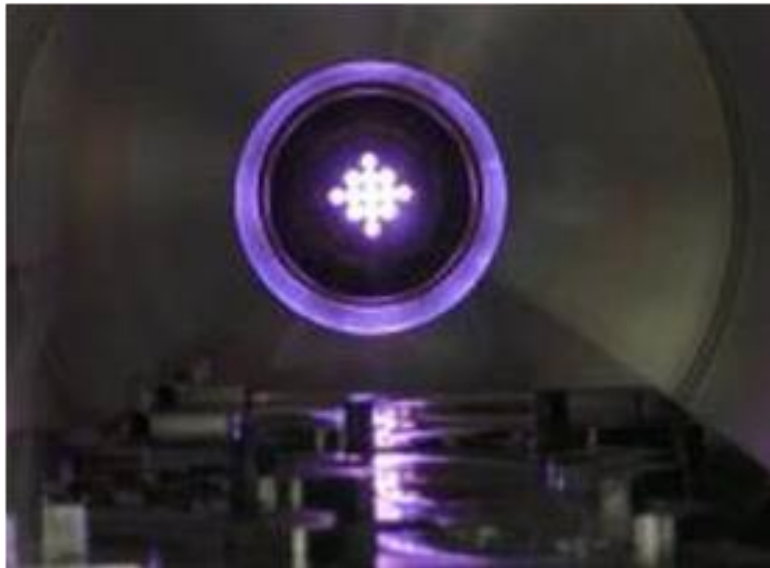
Hydrocarbon containment

- Molecular contamination is more important for 450mm wafer metrology tools because analysis takes longer (as compared to 300mm)
- Advanced contamination control solutions can also be applied to current platforms, yielding:
 - Better resolution
 - Higher tool uptime
 - Less cross contamination
 - ...



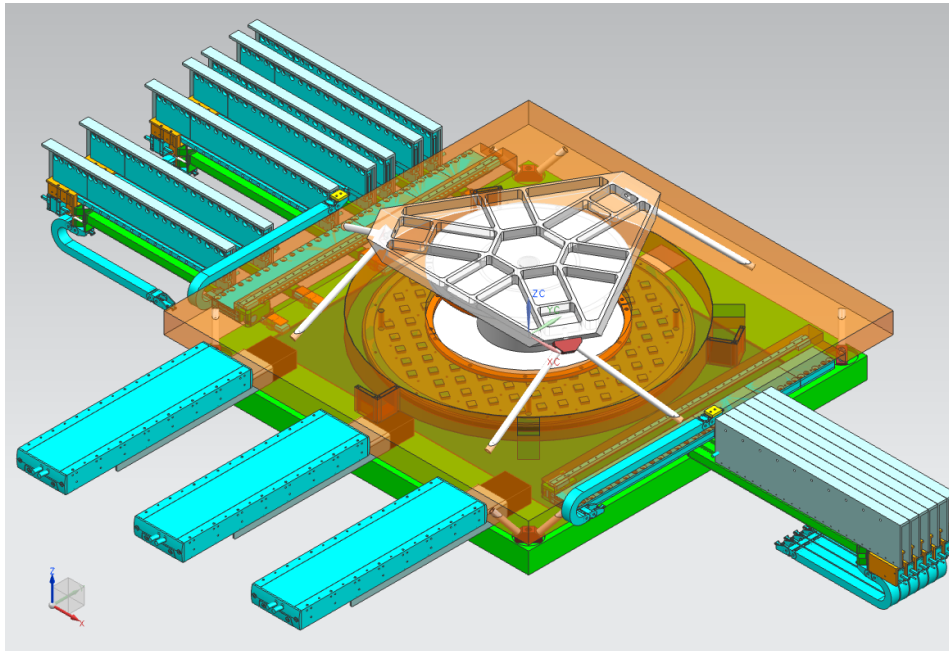
Recent results at TNO

- SMIRP cleaner: gentle on delicate surfaces
- MFIG sensor: fast and sensitive



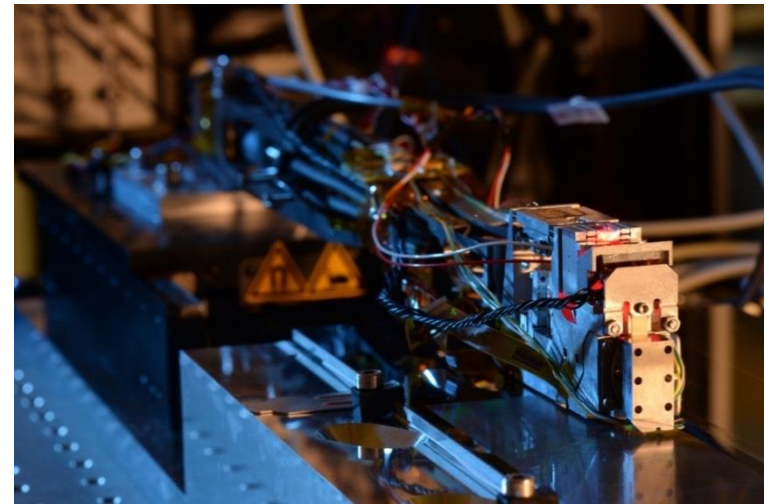
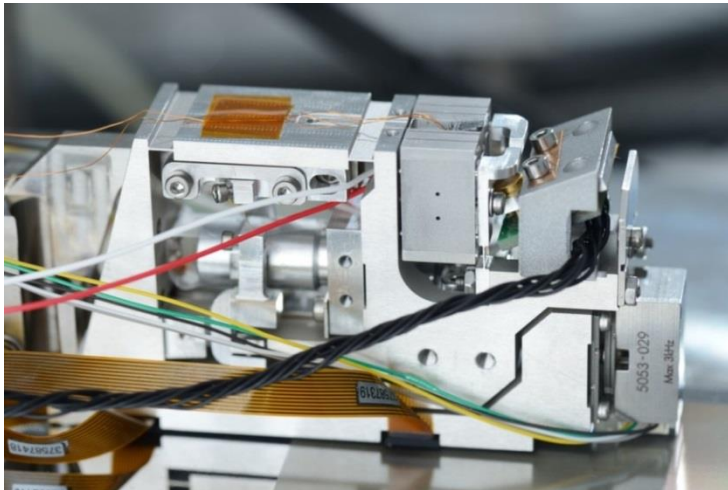
High Throughput Scanning Probe Microscopy

- Classic SPM is for small scan area only ($10 \times 10 \mu\text{m}$)
- TNO is making the step to full size 450mm wafer using parallelization concept
- 300mm wafer and reticle analysis benefit as well!



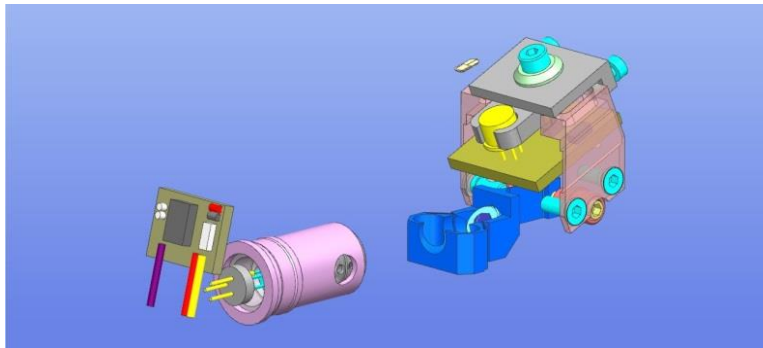
Status last year

- Single arm demonstrator, developed in TNO-internal R&D project

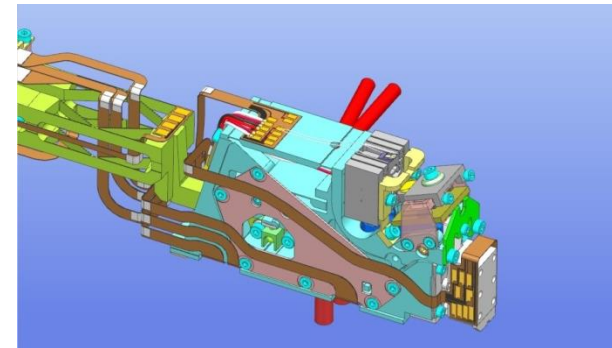


Project progress

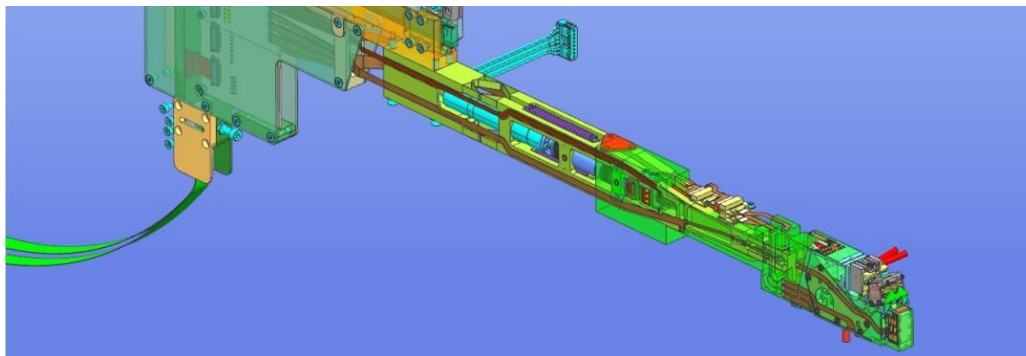
- Updated design for system with parallel arms



optical column



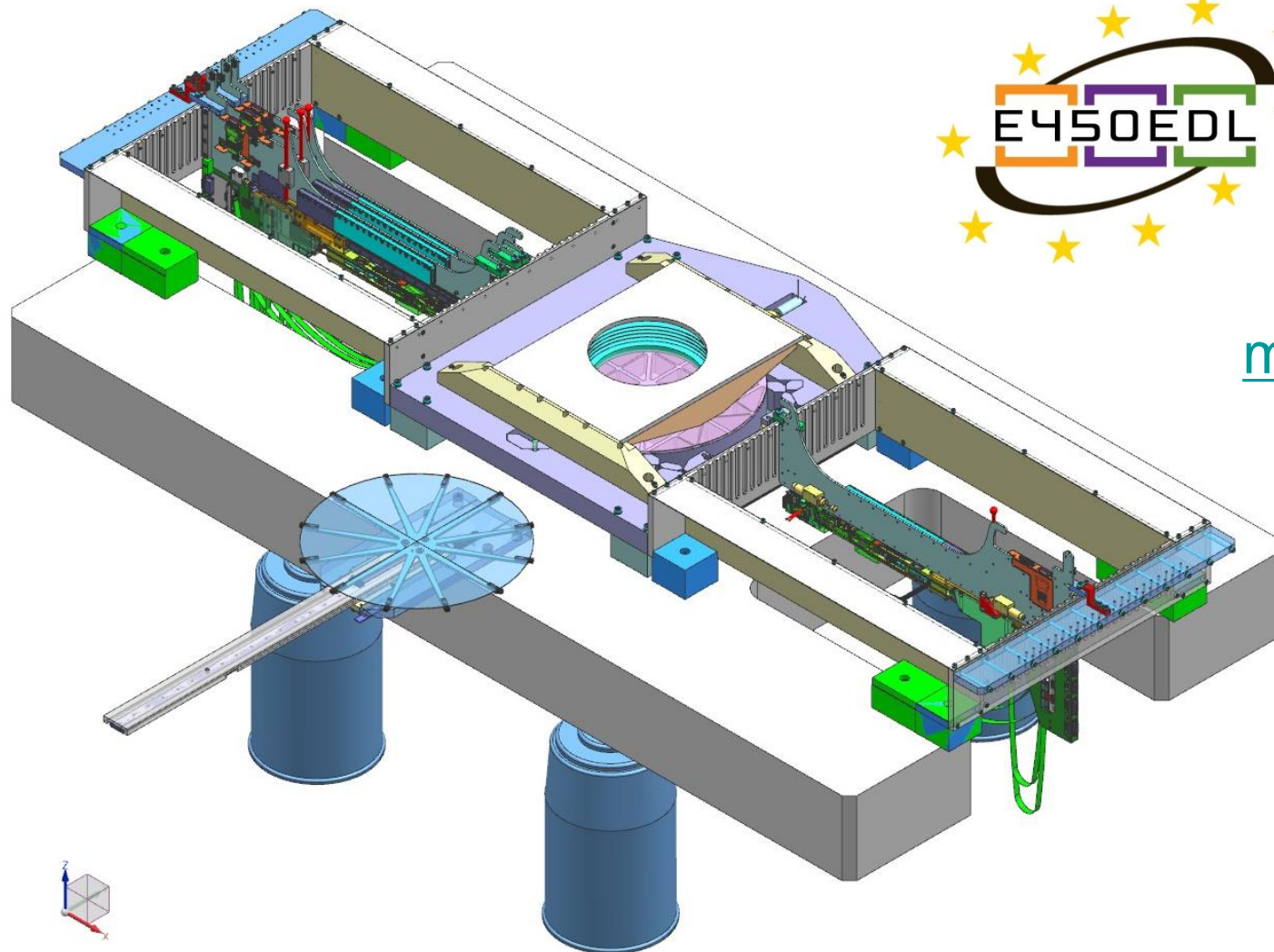
miniature scanhead



positioning unit



Parallel AFM demonstrator currently under construction



[movie](#)

Ultraclean handling

- Ultraclean handling technology developed for 450mm wafers can also be applied to reticles
- Literature shows Particle-per-Reticle-Pass (PRP) Levels in order of 0.01
- Industry reports a need for PRP numbers of 0.001 and 0.0001
- These numbers refer to particle sizes larger than the required defect sizes (ITRS 2014: 20nm)



TNO Reticle Handler platform

- Initial performance:
0.06 PRP
- Current work:
 - Full cleanliness qualification
- Planned work:
 - Further improvement of performance
 - Integration RN4 particle scanner (20nm detection)



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Strategies and opportunities beyond the 450mm transition

- Next nodes requirements
- EUV High Volume Manufacturing
- DSA challenges metrology
- 3D structures
- Quantum computing
- Metamaterials
- ...



Conclusion: bright future ahead!

